Regenerative medicine

A WEEKLY UPDATE FROM INDIA'S FINEST RESEARCH INSTITUTES

Retinal damage and blindness: can we learn

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Retinal damage and blindness: can we learn from zebra fish?

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MANY LOWER vertebrates have the ability to regenerate their organs if they get damaged. Regeneration has an edge over wound-healing, as the former restores tissue types and function. Zebra fish, for example, can regenerate every part of its body, including brain and heart. In higher order vertebrates including human beings, this ability is extremely limited. Humans can only regenerate their skin and, to some extent, their liver after damage.

Human bodies are capable of healing their wounds much faster than any other species. Our central nervous system (CNS) that includes the brain and the spinal chord, has the least regenerative capacity though. Retina, being a readily accessible part of CNS, often undergoes damages during the lifetime of an organism, leading to irreversible blindness.

Retina is like the photographic film of a camera. It is here that the images that human beings see and understand are formed. Any damage to the retina is irreversible, and leads to permanent blindness. Unlike blindness caused by cornea or lens damage, which can be addressed by corneal transplant or intra-ocular lens respectively, the retinal damage has no promising cure. That is because retina is connected to the CNS to enable vision and no regenerative repair is possible in the CNS of humans and hence for the eyes too.

The only possible solution to a problem like this, is to induce a regeneration response in the retina after an acute injury. But this doesn't happen either in humans or other mammals like rats.

THE RESEARCH

Studying retina regeneration in smaller animals like zebra fish and finding out whether those processes can be recreated in human beings

Fishes and humans have almost identical eye structures in terms of cell types and functionality. Interestingly, fishes can regenerate their retina within two weeks post injury.

Almost five percent of the world's population is suffering from retinal problems that can lead to irreversible blindness. A way to regenerate the retina can therefore have extremely useful consequences.

I have been working on this subject since 2007. The idea is to find out the mechanism behind organ regeneration. For our research, we have been studying regeneration in zebra fish.

In the zebra fish retina, there are six types of neurons and one type of glia (non-neuronal cells) performing different kinds of functions. One of them, the Müller glia cells, largely perform supportive function to neurons that enable vision. But after an injury in the CNS leading to loss of vision, these glia cells change their nature and convert themselves into stem cells. These stem cells multiply rapidly and produce cells that were damaged in the injury.

We are trying to study why a similar process does not occur in human beings and what are the factors that make it possible in zebra fish. There is a general concept that in higher mammals the CNS does not allow the multiplication of cells in large numbers. The CNS of human beings is an very 'plastic'. One plausible reason that is offered is that human brain is highly evolved and needs it to perform a large number of operations, often through multi-tasking. In such a scenario retina being part of central nervous system often behaves synonymous to brain and it has a limitation to behave in a certain way on its own, which can interfere with the overall functioning of the brain. But this is only a postulate. We have still not managed to comprehend the complete process.

We employ various cellular, molecular, genetic and pharmacological approaches to understand the mechanism of retinal regeneration. Our research is continuing with the generous support of Wellcome Trust (United Kingdom), Department of Biotechnology (Government of India) India Alliance, and IISER-Mohali. We believe that in the next couple of years, we would be able to find a few clues to the reasons behind organ regeneration in smaller animals and whether those processes can be recreated in human beings. This information will pave way for curing retinal blindness in humans.

For your research to be considered for this column, please write to Senior Editor Amitabh Sinha at amitabh.sinha@expressindia.com